

engineering or architecture, or who have a degree from a community or junior college, with courses in construction technology, drafting, mathematics, and building inspection. Many community colleges offer certificate or associate degree programs in building inspection technology. Courses in blueprint reading, algebra, geometry, and English are also useful.

Construction and building inspectors must be in good physical condition in order to walk and climb about construction sites. They must also have a driver's license. In addition, Federal, State, and many local governments may require that inspectors pass a civil service exam.

Construction and building inspectors usually receive much of their training on the job, although they must learn building codes and standards on their own. Working with an experienced inspector, they learn about inspection techniques; codes, ordinances, and regulations; contract specifications; and record-keeping and reporting duties. They may begin by inspecting less complex types of construction, such as residential buildings, and then progress to more difficult assignments. An engineering or architectural degree is often required for advancement to supervisory positions.

Because they advise builders and the general public on building codes, construction practices, and technical developments, construction and building inspectors must keep abreast of changes in these areas. Continuing education is imperative in this field. Many employers provide formal training programs to broaden inspectors' knowledge of construction materials, practices, and techniques. Inspectors who work for small agencies or firms that do not conduct training programs can expand their knowledge and upgrade their skills by attending State-sponsored training programs, by taking college or correspondence courses, or by attending seminars sponsored by various related organizations such as model code organizations.

Most States and cities require some type of certification for employment and, even if not required, certification can enhance an inspector's opportunities for employment and advancement to more responsible positions. To become certified, inspectors with substantial experience and education must pass stringent examinations on code requirements, construction techniques, and materials. The three major model code organizations offer voluntary certification as do other professional membership associations. In most cases, there are no education or experience prerequisites, and certification consists of passing an examination in a designated field. Many categories of certification are awarded for inspectors and plan examiners in a variety of disciplines, including the designation "CBO," Certified Building Official.

Job Outlook

Employment of construction and building inspectors is expected to grow as fast as the average for all occupations through 2008. Growing concern for public safety and improvements in the quality of construction should continue to stimulate demand for construction and building inspectors. Despite the expected employment growth, most job openings will arise from the need to replace inspectors who transfer to other occupations or leave the labor force. Construction and building inspectors tend to be older, more experienced workers who have spent years working in other occupations.

Opportunities should be best for highly experienced supervisors and craft workers who have some college education, engineering or architectural training, or who are certified as inspectors or plan examiners. Thorough knowledge of construction practices and skills in areas such as reading and evaluating blueprints and plans are essential. However, inspectors are involved in all phases of construction, including maintenance and repair work, and are therefore less likely to lose jobs during recessionary periods when new construction slows. As the population grows and the volume of real estate transactions increases, greater emphasis on home inspections should result in rapid growth in employment of home inspectors. In addition, there should be good opportunities in engineering, architectural, and management services firms due to the tendency of governments—particularly the Federal

and State—to contract out inspection work, as well as expected growth in private inspection services.

Earnings

Median annual earnings of construction and building inspectors were \$37,540 in 1998. The middle 50 percent earned between \$29,540 and \$47,040. The lowest 10 percent earned less than \$22,770 and the highest 10 percent earned more than \$61,820. Median annual earnings in the industries employing the largest numbers of construction and building inspectors in 1997 were:

Engineering and architectural services	\$36,500
Local government, except education and hospitals	36,300
State government, except education and hospitals	32,700

Generally, building inspectors, including plan examiners, earn the highest salaries. Salaries in large metropolitan areas are substantially higher than those in small local jurisdictions.

Related Occupations

Construction and building inspectors combine knowledge of construction principles and law with an ability to coordinate data, diagnose problems, and communicate with people. Workers in other occupations using a similar combination of skills include engineers, drafters, estimators, industrial engineering technicians, surveyors, architects, and construction managers.

Sources of Additional Information

Information about certification and a career as a construction or building inspector is available from the following model code organizations:

- International Conference of Building Officials, 5360 Workman Mill Rd., Whittier, CA 90601-2298. Internet: <http://www.icbo.org>
- Building Officials and Code Administrators International, Inc., 4051 West Flossmoor Rd., Country Club Hills, IL 60478. Internet: <http://www.bocai.org>
- Southern Building Code Congress International, Inc., 900 Montclair Rd., Birmingham, AL 35213.

Information about a career as a home inspector is available from:

- American Society of Home Inspectors, Inc., 932 Lee St., Suite 101, Des Plaines, IL 60016. Internet: <http://www.ashi.com>

For information about a career as a State or local government construction or building inspector, contact your State or local employment service.

Construction Managers

(O*NET 15017B)

Significant Points

- Construction managers must be available, often 24 hours a day, to deal with delays, bad weather, or emergencies at the site.
- The increasing level and complexity of construction activity should spur demand for managers.
- Individuals who combine industry work experience with a bachelor's degree in construction or building science or construction management should have the best job prospects.

Nature of the Work

Construction managers plan and direct construction projects. They may have job titles, such as *constructor*, *construction superintendent*, *general superintendent*, *project engineer*, *project manager*, *general construction manager*, or *executive construction manager*. Construction

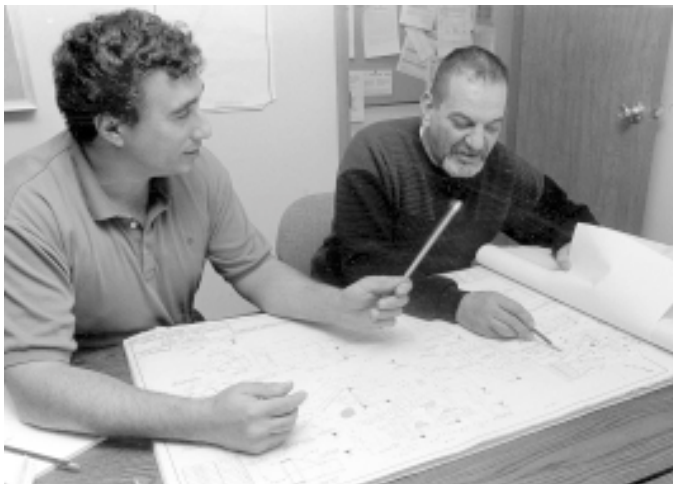
managers may be owners or salaried employees of a construction management or contracting firm, or may work under contract or as a salaried employee of the owner, developer, contractor, or management firm overseeing the construction project. The *Handbook* uses the term “construction manager” to describe salaried or self-employed managers who oversee construction supervisors and workers.

In contrast with the *Handbook* definition, “construction manager” is defined more narrowly within the construction industry to denote a management firm, or an individual employed by such a firm, involved in management oversight of a construction project. Under this definition, construction managers usually represent the owner or developer with other participants throughout the project. Although they usually play no direct role in the actual construction of a structure, they typically schedule and coordinate all design and construction processes including the selection, hiring, and oversight of specialty trade contractors.

Managers and professionals who work in the construction industry, such as general managers, project engineers, cost estimators, and others, are increasingly called *constructors*. Through education and past work experience, this broad group of professionals manages, coordinates, and supervises the construction process from the conceptual development stage through final construction on a timely and economical basis. Given designs for buildings, roads, bridges, or other projects, constructors oversee the organization, scheduling, and implementation of the project to execute those designs. They are responsible for coordinating and managing people, materials, and equipment; budgets, schedules, and contracts; and the safety of employees and the general public.

On large projects, construction managers may work for a *general contractor*—the firm with overall responsibility for all activities. There they oversee the completion of all construction in accordance with the engineer or architect’s drawings and specifications and prevailing building codes. They arrange for *trade contractors* to perform specialized craft work or other specified construction work. On small projects, such as remodeling a home, a self-employed construction manager or skilled trades worker who directs and oversees employees is often referred to as the construction “contractor.”

Large construction projects, such as an office building or industrial complex, are too complicated for one person to manage. These projects are divided into many segments: Site preparation, including land clearing and earth moving; sewage systems; landscaping and road construction; building construction, including excavation and laying foundations, erection of structural framework, floors, walls, and roofs; and building systems, including fire protection, electrical, plumbing, air-conditioning, and heating. Construction managers may work as part of a team or be in charge of one or more of these activities.



Construction managers regularly review engineering and architectural drawings to monitor work progress and ensure compliance with specifications.

Construction managers evaluate various construction methods and determine the most cost-effective plan and schedule. They determine the appropriate construction methods and schedule all required construction site activities into logical, specific steps, budgeting the time required to meet established deadlines. This may require sophisticated estimating and scheduling techniques, and use of computers with specialized software. This also involves the selection and coordination of trade contractors hired to complete specific pieces of the project—which could include everything from structural metalworking and plumbing, to painting and carpet installation. Construction managers determine the labor requirements and, in some cases, supervise or monitor the hiring and dismissal of workers. They oversee the performance of all trade contractors and are responsible for ensuring all work is completed on schedule.

Construction managers direct and monitor the progress of construction activities, at times through other construction supervisors. This includes the delivery and use of materials, tools, and equipment; the quality of construction, worker productivity, and safety. They are responsible for obtaining all necessary permits and licenses and, depending upon the contractual arrangements, direct or monitor compliance with building and safety codes and other regulations. They may have several subordinates, such as assistant managers or superintendents, field engineers, or crew supervisors, reporting to them.

Construction managers regularly review engineering and architectural drawings and specifications to monitor progress and ensure compliance with plans and specifications. They track and control construction costs to avoid cost overruns. Based upon direct observation and reports by subordinate supervisors, managers may prepare daily reports of progress and requirements for labor, material, and machinery and equipment at the construction site. They meet regularly with owners, trade contractors, architects, and other design professionals to monitor and coordinate all phases of the construction project.

Working Conditions

Construction managers work out of a main office from which the overall construction project is monitored, or out of a field office at the construction site. Management decisions regarding daily construction activities are usually made at the job site. Managers usually travel when the construction site is in another State or when they are responsible for activities at two or more sites. Management of overseas construction projects usually entails temporary residence in another country.

Construction managers must be “on call,” often 24 hours a day, to deal with delays, bad weather, or emergencies at the site. Most work more than a standard 40-hour week because construction may proceed around-the-clock. This type of work schedule can go on for days, even weeks, to meet special project deadlines, especially if there are delays.

Although the work usually is not considered inherently dangerous, construction managers must be careful while touring construction sites. Managers must establish priorities and assign duties. They need to observe job conditions and to be alert to changes and potential problems, particularly involving safety on the job site and adherence to regulations.

Employment

Construction managers held about 270,000 jobs in 1998. Around 45,000 were self-employed. About 85 percent of salaried construction managers were employed in the construction industry, about 36 percent by specialty trade contractors—for example, plumbing, heating and air-conditioning, and electrical contractors—and about 38 percent by general building contractors. Engineering, architectural, and construction management services firms, as well as local governments, educational institutions, and real estate developers employed others.

Training, Other Qualifications, and Advancement

Persons interested in becoming a construction manager need a solid background in building science, business, and management, as well as

related work experience within the construction industry. They need to understand contracts, plans, and specifications, and to be knowledgeable about construction methods, materials, and regulations. Familiarity with computers and software programs for job costing, scheduling, and estimating is increasingly important.

Traditionally, persons advance to construction management positions after having substantial experience as construction craft workers—carpenters, masons, plumbers, or electricians, for example—or after having worked as construction supervisors or as owners of independent specialty contracting firms overseeing workers in one or more construction trades. However, more and more employers—particularly, large construction firms—hire individuals who combine industry work experience with a bachelor's degree in construction or building science or construction management. Practical industry experience is very important, whether through internships, cooperative education programs, or tenure in the industry.

Construction managers should be flexible and work effectively in a fast-paced environment. They should be decisive and work well under pressure, particularly when faced with unexpected occurrences or delays. The ability to coordinate several major activities at once, while analyzing and resolving specific problems, is essential, as is understanding engineering, architectural, and other construction drawings. Good oral and written communication skills are also important, as are leadership skills. Managers must be able to establish a good working relationship with many different people, including owners, other managers, design professionals, supervisors, and craft workers.

Advancement opportunities for construction managers vary depending upon an individual's performance, and the size and type of company for which they work. Within large firms, managers may eventually become top-level managers or executives. Highly experienced individuals may become independent consultants; some serve as expert witnesses in court or as arbitrators in disputes. Those with the required capital may establish their own construction management services, specialty contracting or general contracting firm.

In 1998, over 100 colleges and universities offered 4-year degree programs in construction management or construction science. These programs include courses in project control and development, site planning, design, construction methods, construction materials, value analysis, cost estimating, scheduling, contract administration, accounting, business and financial management, building codes and standards, inspection procedures, engineering and architectural sciences, mathematics, statistics, and information technology. Graduates from 4-year degree programs are usually hired as assistants to project managers, field engineers, schedulers, or cost estimators. An increasing number of graduates in related fields—engineering or architecture, for example—also enter construction management, often after having had substantial experience on construction projects or after completing graduate studies in construction management or building science.

Around 30 colleges and universities offer a master's degree program in construction management or construction science, and at least two offer a Ph.D. in the field. Master's degree recipients, especially those with work experience in construction, typically become construction managers in very large construction or construction management companies. Often, individuals who hold a bachelor's degree in an unrelated field seek a master's degree in order to work in the construction industry. Doctoral degree recipients usually become college professors or conduct research.

Many individuals also attend training and educational programs sponsored by industry associations, often in collaboration with postsecondary institutions. A number of 2-year colleges throughout the country offer construction management or construction technology programs.

Both the American Institute of Constructors (AIC) and the Construction Management Association of America (CMAA) have established voluntary certification programs for construction professionals. Requirements combine written examinations with verification of professional experience. AIC awards the designations Associate Constructor (AC) and Certified Professional Constructor (CPC) to candidates who meet the requirements and pass appropriate construction

examinations. CMAA awards the designation Certified Construction Manager (CCM) to practitioners who meet the requirements in a construction management firm, complete a professional construction management "capstone" course, and pass a technical examination. Although certification is not required to work in the construction industry, voluntary certification can be valuable because it provides evidence of competence and experience.

Job Outlook

Employment of construction managers is expected to increase about as fast as the average for all occupations through 2008, as the level and complexity of construction activity continues to grow. Prospects in construction management, engineering and architectural services, and construction contracting firms should be best for persons who have a bachelor's or higher degree in construction science, construction management, or construction engineering as well as practical experience working in construction. Employers prefer applicants with previous construction work experience who can combine a strong background in building technology with proven supervisory or managerial skills. In addition to job growth, many openings should result annually from the need to replace workers who transfer to other occupations or leave the labor force.

The increasing complexity of construction projects should increase demand for management level personnel within the construction industry, as sophisticated technology and the proliferation of laws setting standards for buildings and construction materials, worker safety, energy efficiency, and environmental protection have further complicated the construction process. Advances in building materials and construction methods and the growing number of multipurpose buildings, electronically operated "smart" buildings, and energy-efficient structures will further add to the demand for more construction managers. However, employment of construction managers can be sensitive to the short-term nature of many construction projects and cyclical fluctuations in construction activity.

Earnings

Earnings of salaried construction managers and self-employed independent construction contractors vary depending upon the size and nature of the construction project, its geographic location, and economic conditions. In addition to typical benefits, many salaried construction managers receive benefits such as bonuses and use of company motor vehicles.

Median annual earnings of construction managers in 1998 were \$47,610. The middle 50 percent earned between \$36,360 and \$70,910. The lowest 10 percent earned less than \$28,970, and the highest 10 percent earned more than \$89,480. Median annual earnings in the industries employing the largest numbers of managers in 1997 were:

Nonresidential building construction	\$47,700
Plumbing, heating, and air conditioning	47,000
Heavy construction, except highway	45,700
Miscellaneous special trade contractors	44,200
Residential building construction	40,600

According to a 1999 salary survey by the National Association of Colleges and Employers, candidates with a bachelor's degree in construction management received offers averaging \$34,300 a year. Bachelor's degree candidates with degrees in construction science received offers averaging \$36,600.

Related Occupations

Construction managers participate in the conceptual development of a construction project and oversee its organization, scheduling, and implementation. Occupations in which similar functions are performed include architects, civil engineers, construction supervisors, cost engineers, cost estimators, real estate developers, electrical engineers, industrial engineers, landscape architects, and mechanical engineers.

Sources of Information

For information about career opportunities in the construction industry, contact:

• Associated Builders and Contractors, 1300 North 17th St., Rosslyn, VA 22209. Internet: <http://www.abc.org>

• Associated General Contractors of America, 1957 E St. NW, Washington, DC 20006-5199. Internet: <http://www.agc.org>

For information about constructor certification and professional career opportunities in the construction industry, contact:

• American Institute of Constructors, 466 94th Ave. North, St. Petersburg, FL 33702. Internet: <http://www.aicnet.org>

For information about construction management and construction manager certification, contact:

• Construction Management Association of America, 7918 Jones Branch Dr., Suite 540, McLean, VA 22102. Internet: <http://www.access.digex.net/~cmaa>

Information on accredited construction science and management programs and accreditation requirements is available from:

• American Council for Construction Education, 1300 Hudson Lane, Suite 3, Monroe, LA 71201-6054. Internet: <http://www.acce.org>

Cost Estimators

(O*NET 21902 and 85305D)

Significant Points

- Growth of the construction industry, where about 58 percent of all cost estimators are employed, will be the driving force behind the demand for these workers.
- Job prospects in construction should be best for those workers with a degree in construction management or construction science, engineering, or architecture, and who have practical experience in various phases of construction or in a specialty craft area.

Nature of the Work

Accurately forecasting the cost of future projects is vital to the survival of any business. Cost estimators develop cost information for owners or managers to use in determining resource and material quantities, making bids for contracts, determining if a new product will be profitable, or determining which products are making a profit for a firm.

Regardless of the industry in which they work, estimators compile and analyze data on all the factors that can influence costs—such as materials, labor, location, and special machinery requirements, including computer hardware and software. Job duties vary widely depending on the type and size of the project. *Costs engineers* usually have an engineering background and apply scientific principles and methods to undertake feasibility studies, value engineering, and life-cycle costing.

The methods of and motivations for estimating costs can vary greatly, depending on the industry. On a construction project, for example, the estimating process begins with the decision to submit a bid. After reviewing various drawings and specifications, the estimator visits the site of the proposed project. The estimator needs to gather information on access to the site and availability of electricity, water, and other services, as well as surface topography and drainage. The information developed during the site visit usually is recorded in a signed report that is made part of the final project estimate.

After the site visit is completed, the estimator determines the quantity of materials and labor the firm will have to furnish. This process, called the quantity survey or “takeoff,” involves completing standard estimating forms, filling in dimensions, number of units, and other information. A cost estimator working for a general contractor, for example, will estimate the costs of all items the contractor must provide. Although subcontractors will estimate their costs as part of their own bidding process, the general contractor’s cost estimator often analyzes

bids made by subcontractors as well. Also during the takeoff process, the estimator must make decisions concerning equipment needs, sequence of operations, and crew size. Allowances for the waste of materials, inclement weather, shipping delays, and other factors that may increase costs must also be incorporated in the estimate.

On completion of the quantity surveys, the estimator prepares a total project cost summary, including the costs of labor, equipment, materials, subcontracts, overhead, taxes, insurance, markup, and any other costs that may affect the project. The chief estimator then prepares the bid proposal for submission to the owner.

Construction cost estimators may also be employed by the project’s architect or owner to estimate costs or track actual costs relative to bid specifications as the project develops. In large construction companies employing more than one estimator, it is common practice for estimators to specialize. For instance, one may estimate only electrical work and another may concentrate on excavation, concrete, and forms.

In manufacturing and other firms, cost estimators usually are assigned to the engineering, cost, or pricing departments. The estimators’ goal in manufacturing is to accurately estimate the costs associated with making products. The job may begin when management requests an estimate of the costs associated with a major redesign of an existing product or the development of a new product or production process. When estimating the cost of developing a new product, for example, the estimator works with engineers, first reviewing blueprints or conceptual drawings to determine the machining operations, tools, gauges, and materials that would be required for the job. The estimator then prepares a parts list and determines whether it is more efficient to produce or to purchase the parts. To do this, the estimator must initiate inquiries for price information from potential suppliers. The next step is to determine the cost of manufacturing each component of the product. Some high technology products require a tremendous amount of computer programming during the design phase. The cost of software development is one of the fastest growing and most difficult activities to estimate. Some cost estimators now specialize in only estimating computer software development and related costs.

The cost estimator then prepares time-phase charts and learning curves. Time-phase charts indicate the time required for tool design and fabrication, tool “debugging”—finding and correcting all problems—manufacturing of parts, assembly, and testing. Learning curves graphically represent the rate at which performance improves with practice. These curves are commonly called “cost reduction” curves because many problems—such as engineering changes, rework, parts shortages, and lack of operator skills—diminish as the number of parts produced increases, resulting in lower unit costs.



Cost estimators compile and analyze data on all factors that can influence costs, including materials, labor, location, and special machinery requirements.